



Towards Socio- and Neuro-feedback Treatment for Schizophrenia

By:

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Introduction

- **Schizophrenia** is a chronic and disabling mental disorder that often develops in adolescence and has a heterogeneous presentation characterized broadly by positive (hallucinations and delusions), negative (apathy, blunting of affect and alogia) and cognitive (attention, memory and executive functioning) symptoms.
- **Negative symptoms** in schizophrenia are associated with significant burden and functional impairment, especially of speech patterns.

Motivation

- In clinical practice today, there are no robust treatments for negative symptoms and one obstacle surrounding its research is the lack of an objective measure.
- In this work, we explore non-verbal speech cues as objective measures. Specifically, we extract these non-verbal cues from recorded interviews of schizophrenic patients and psychologists.
- Our ultimate aim is to design a mobile or telemedicine application that can continuously monitor patients by inferring NSA scores from speech data acquired from patient's personal device.

Explanation of terms

- **CRT (cognitive remediation therapy)** is designed to improve neurocognitive abilities such as attention, working memory, cognitive flexibility and planning, and executive functioning which leads to improved social functioning.

Explanation of terms

- There are several subtypes of schizophrenia, but generally speaking the symptoms are often classified into two broad categories: **positive** and **negative** symptoms.
 - Positive symptoms refer to those behaviours or condition that are present in schizophrenia but that are not present under typical conditions (hallucinations, delusions).
 - Negative symptoms refer to those behaviours that are conspicuous because of their absence (grooming, language, communication). Several measures or rating scales have been developed to assess the positive and negative aspects of schizophrenia.

Explanation of terms

- The **Scale for the Assessment of Negative Symptoms (SANS)** is a rating scale to measure negative symptoms in schizophrenia. The scale has five major domains:
 - **Affective Flattening or Blunting**
 - **Alogia**
 - **Avolition – Apathy**
 - **Anhedonia – Asociality**
 - **Attention**

Objectives

- The major objectives of this project are to explore:
 - The correlation of non-verbal speech cues and NSA ratings.
 - The differences between control and subject groups.
 - The effect of CRT treatment on subjects over multiple sessions.

Experiment Design

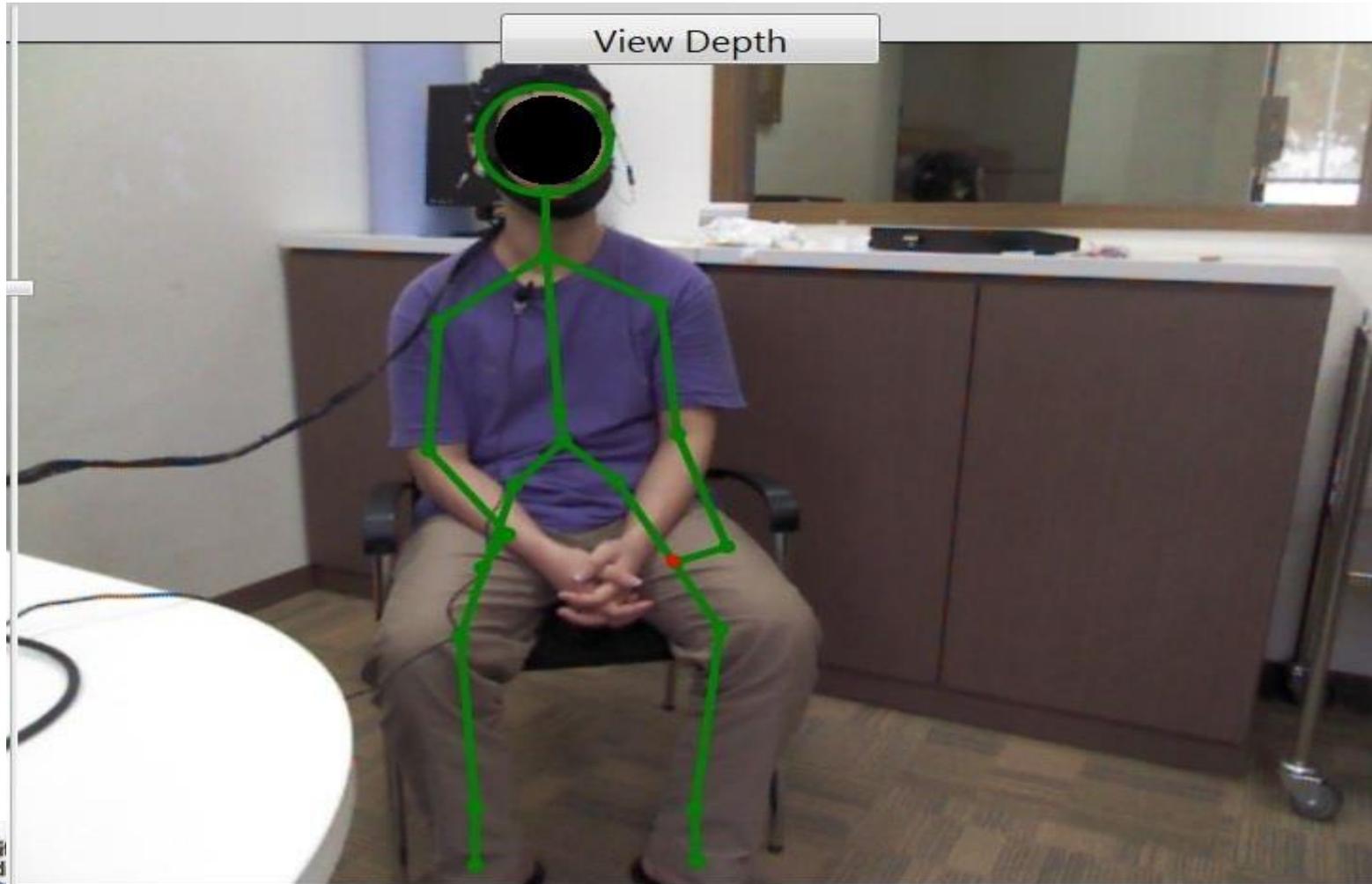
- We are working in collaboration with **ASTAR** brain computer interface group and **IMH** (Institute for Mental Health), Singapore.
- IMH has recruited two sets of patients for this experiment:
 - The subjects group are schizophrenic patients receiving CRT (cognitive remediation therapy) treatment.
 - The control group are schizophrenic patients not receiving any treatment.
- Each patient comes for three assessment sessions at week 0, week 2 and week 12.

Experiment Design

- Each assessment session has two major parts:
 - A cognitive task where the patient does some memory tasks. EEG data is recorded for this task.
 - A structured interview with a psychologist, where EEG , audio and visual data is recorded.
- We are working on audio-visual data collected during the structured interview.
- In this presentation I will present the results for audio analysis of 20 patients (9 controls and 11 subjects).

Experiment Setup

- The following figure explains the experimental setup for this project:



Non-Verbal Speech Features

- Some of the non-verbal speech features extracted from the interview sessions are listed in the table below:-

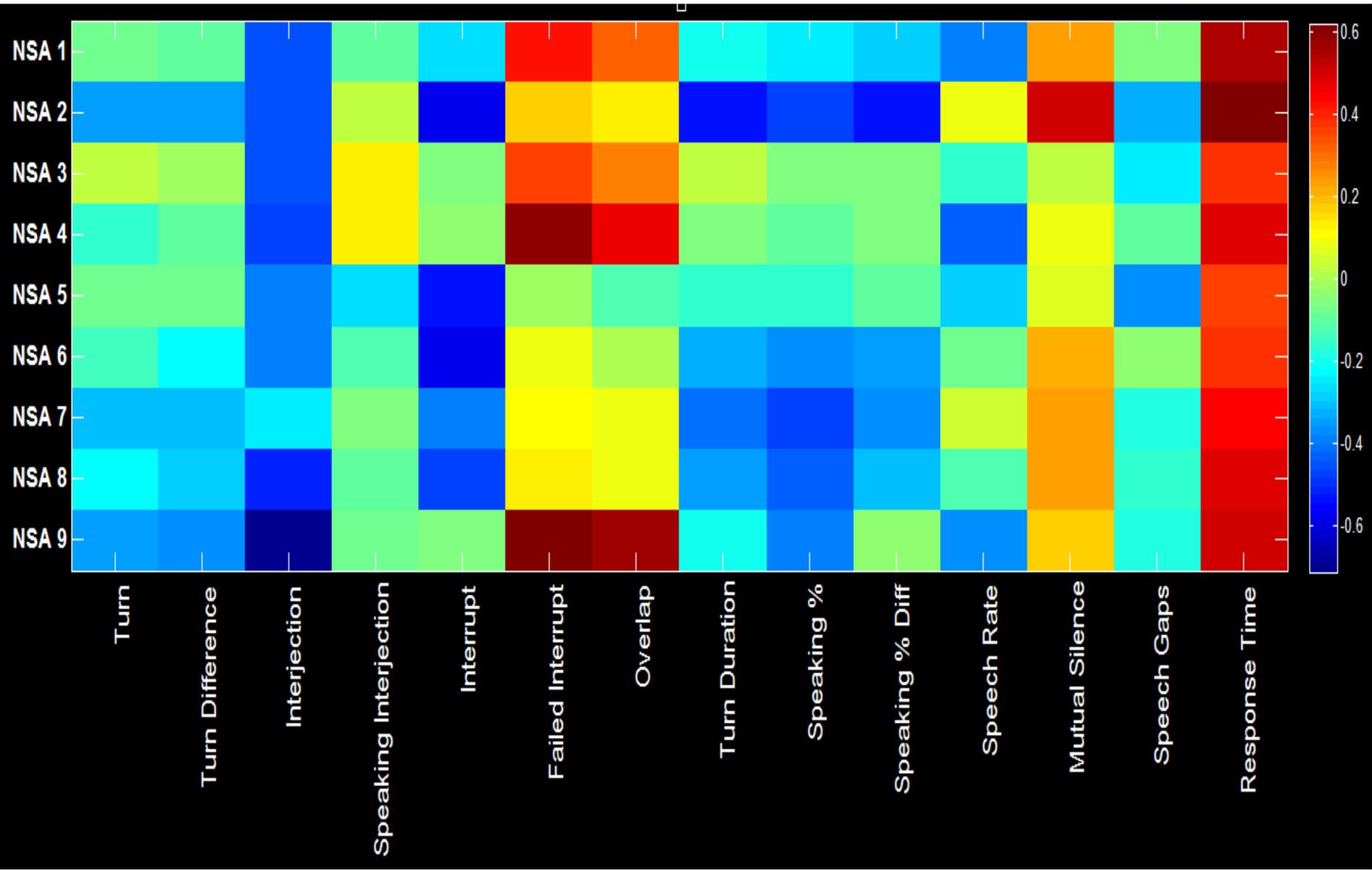
Feature	Description
Natural Turn-Taking	The number of times person 'A' speaks in the conversation without interrupting person 'B'
Speaking %	The percentage of time a person speaks in the conversation.
Speaking Rate	The number of syllables spoken per minute.
Mutual Silence %	The percentage of time when both participants are silent.
Interruption	Person 'A' interrupts person 'B' while speaking, and takes over. Person 'B' stops speaking before person 'A' does
Speaking Interjection	Short utterances such as 'ok', 'hmm' etc when other speaker is speaking.
Turn Duration	Average duration of each speaker's turns.
Response Time	If person 'A' finishes speaking, then the time taken for person 'B' to start speaking is called response time.

Correlation Analysis

- We determined the correlation between negative symptoms assessment (NSA) and non-verbal audio features.
- The results indicate that NSA criteria related to speech and non-verbal audio features are correlated.

Correlation Analysis

	Interject	Interrupt	Failed_Interrupt	Overlap	Speaking	Turn_Duration	Mutual_Silence	Response_Time
prolonged time to respond	-0.45	-0.27	0.41	0.32	-0.21	-0.29	0.23	0.55
restricted speech quantity	-0.45	-0.57	0.17	0.12	-0.53	-0.53	0.5	0.62
impoverished speech content	-0.45	-0.05	0.35	0.28	0.03	-0.05	0.03	0.39
inarticulate speech	-0.48	-0.02	0.58	0.46	-0.05	-0.05	0.08	0.5
emotion reduced range	-0.39	-0.53	-0.01	-0.11	-0.17	-0.1	0.07	0.37
affect reduced modulation of intensity	-0.39	-0.59	0.09	0.02	-0.32	-0.36	0.22	0.39
affect reduced display on demand	-0.24	-0.39	0.11	0.1	-0.4	-0.38	0.24	0.45
reduced social drive	-0.52	-0.48	0.13	0.08	-0.36	-0.31	0.23	0.48
poor rapport with interviewer	-0.71	-0.06	0.61	0.57	-0.21	-0.03	0.18	0.5



Prediction of NSA criteria based on non-verbal audio features

Negative Symptoms	SVM	SVR	Rmse	Mae
Prolonged time of response	75%	75%	0.89	0.4
Restricted speech quantity	80%	60%	0.94	0.4
Poor rapport with interviewer	80%	65%	1	0.4

Differentiating Control and Subject groups

- We labelled the control and subject data as two separate classes. Trained an algorithm to distinguish between the two classes using the extracted features.
- The results were calculated using leave-one-person out cross validation technique.
- We separated data for session1, session2 and session3 and then ran the algorithm to calculate detection accuracies for each session.

Data sets	Accuracy	Dataset size	Wrongly classified controls	Wrongly classified subjects
Session 1	69%	19	4	2
Session 2	90%	20	0	2
Session 3	75%	20	2	3
All sessions averaged	75%	20	4	1

Conclusion

- Our results suggest a strong correlation between certain measures of the two rating sets.
- Supervised prediction of the subjective ratings from the non-verbal speech features with leave-one-person-out cross-validation has reasonable accuracy of 75-80%.
- Furthermore, the non-verbal cues can be used to distinguish between the subjects and controls, as supervised learning methods can classify the two groups with around 75% accuracy.

Future work

- This is an ongoing project so we will update our results as we complete the assessment sessions for more participants.
- We are currently extracting visual features from the interview recordings. In future work we will combine audio-visual features to explore the correlations between objective and subjective measures.
- We have recently started collecting data for healthy participants. Once we have sufficient data we will compare those features with existing patient data.

Thank You for Your Attention Questions?